

VISIT...

LANZAROTE
Caliente.COM

VI

Power Quality

S.M. Halpin

Auburn University

28	Introduction	<i>S.M. Halpin</i>	28-1
29	Wiring and Grounding for Power Quality	<i>Christopher J. Melhorn</i>	29-1
	Definitions and Standards • Reasons for Grounding • Typical Wiring and Grounding Problems • Case Study		
30	Harmonics in Power Systems	<i>S.M. Halpin</i>	30-1
31	Voltage Sags	<i>Math H.J. Bollen</i>	31-1
	Voltage Sag Characteristics • Equipment Voltage Tolerance • Mitigation of Voltage Sags		
32	Voltage Fluctuations and Lamp Flicker in Power Systems	<i>S.M. Halpin</i>	32-1
33	Power Quality Monitoring	<i>Patrick Coleman</i>	33-1
	Selecting a Monitoring Point • What to Monitor • Selecting a Monitor • Summary		

28

Introduction

S.M. Halpin

Auburn University

Electric power quality has emerged as a major area of electric power engineering. The predominant reason for this emergence is the increase in sensitivity of end-use equipment. This chapter is devoted to various aspects of power quality as it impacts utility companies and their customers and includes material on (1) grounding, (2) voltage sags, (3) harmonics, (4) voltage flicker, and (5) long-term monitoring. While these five topics do not cover all aspects of power quality, they provide the reader with a broad-based overview that should serve to increase overall understanding of problems related to power quality.

Proper grounding of equipment is essential for safe and proper operation of sensitive electronic equipment. In times past, it was thought by some that equipment grounding as specified in the U.S. by the National Electric Code was in contrast with methods needed to insure power quality. Since those early times, significant evidence has emerged to support the position that, in the vast majority of instances, grounding according to the National Electric Code is essential to insure proper and trouble-free equipment operation, and also to insure the safety of associated personnel.

Other than poor grounding practices, voltage sags due primarily to system faults are probably the most significant of all power quality problems. Voltage sags due to short circuits are often seen at distances very remote from the fault point, thereby affecting a potentially large number of utility customers. Coupled with the wide-area impact of a fault event is the fact that there is no effective preventive for all power system faults. End-use equipment will, therefore, be exposed to short periods of reduced voltage which may or may not lead to malfunctions.

Like voltage sags, the concerns associated with flicker are also related to voltage variations. Voltage flicker, however, is tied to the likelihood of a human observer to become annoyed by the variations in the output of a lamp when the supply voltage amplitude is varying. In most cases, voltage flicker considers (at least approximately) periodic voltage fluctuations with frequencies less than about 30–35 Hz that are small in size. Human perception, rather than equipment malfunction, is the relevant factor when considering voltage flicker.

For many periodic waveform (either voltage or current) variations, the power of classical Fourier series theory can be applied. The terms in the Fourier series are called harmonics; relevant harmonic terms may have frequencies above or below the fundamental power system frequency. In most cases, nonfundamental frequency equipment currents produce voltages in the power delivery system at those same frequencies. This voltage distortion is present in the supply to other end-use equipment and can lead to improper operation of the equipment.

Harmonics, like most other power quality problems, require significant amounts of measured data in order for the problem to be diagnosed accurately. Monitoring may be short- or long-term and may be

relatively cheap or very costly and often represents the majority of the work required to develop power quality solutions.

In summary, the power quality problems associated with grounding, voltage sags, harmonics, and voltage flicker are those most often encountered in practice. It should be recognized that the voltage and current transients associated with common events like lightning strokes and capacitor switching can also negatively impact end-use equipment. Because transients are covered in a separate chapter of this book, they are not considered further in this chapter.